sections from the texture decision map corresponding to objects, which do not have a texture property value within a first predetermined range, and a shape property value within a second predetermined range.

In the preferred embodiment of the invention, the first predetermined range corresponds to valid texture property values of valid monetary banknotes. The second predetermined range corresponds to valid shape property values of valid monetary banknotes. Therefore, should an identified object have both a texture property value and shape property value within the above valid ranges (both corresponding to a valid monetary banknote), its corresponding texture sections are left in the texture decision map to verify a location of valid monetary banknote within the scanned image. Otherwise, if either the texture property value or shape property value of the object are not within the above respective ranges, their corresponding texture sections are removed from the texture decision map.

FIG. 8 illustrates an example of object removal 170 according to the present invention. 8(a) illustrates a texture decision map with three identified objects. Although texture property values are calculated for all three objects, it is evident that the smaller objects on the left, and below, clearly do not correspond with that of a valid monetary banknote. In 8(b), the smaller objects described above are removed upon Object removal 170, as they do not have shape property values within the second predetermined range.

A process flow chart for the verification method for determining areas within an image corresponding to monetary banknotes is presented in FIG. 9. Provided that substantially the same result is achieved, the steps of process 900 need not be in the exact order shown and need not be contiguous, that is, other steps can be intermediate. The method comprises:

Step 910: Divide the image into a plurality of image sections.

Step 920: Generate a banknote boundary map having border sections selected from the image sections, the border sections corresponding to a boundary of monetary banknotes within the image.

Step 930: Generate a texture decision map having texture sections selected from the image sections, the texture sections having a texture value within a valid range according to a valid monetary banknote.

Step 940: Determine a number of objects in the texture decision map by removing texture sections in the texture decision map that correspond to the border sections in the banknote boundary map.

Step 950: Calculate a texture property value for each object according to a texture feature map having a texture feature value for each image section.

Step 960: Calculate a shape property value for each object.

Step 970: Remove texture sections from the texture decision map corresponding to objects that do not have the texture property value within a first predetermined range and the shape property value within a second predetermined range.

FIGS. 10 and 11 illustrate a complete step-by-step verification process as detailed above. In both cases, a texture decision map 1000 and banknote boundary map 1002 are derived from a scanned image 1001. Information from these two maps 1000, 1002 are combined in object determination to identify and isolate potential objects 1004 relating to banknote locations. Shape property values and texture property values are then determined for each object 1004. In object removal 1006, objects 1004 not having texture property values in a first predetermined range and the shape property values in a second predetermined range are then removed.

The final output 1010 illustrates verified locations corresponding to valid monetary banknotes within the scanned image 1001.

The above detailed present invention therefore provides a verification method for determining areas within an image corresponding to monetary banknotes. Characteristics of the scanned image are compared with that of known values and/or ranges of valid monetary banknotes for verifying banknote locations within the image.

The method can be applied for use in the detection of counterfeit currency. The scanned image can contain the sample monetary banknote while superimposed onto any arbitrary background, contain multiple isolated or independent banknotes, have overlapping banknotes, or have arbitrary rotational and shift alignments.

Use of the present invention method not only provides an increased means of security measures when used in application for counterfeit banknote detection, it also provides ease of integration with common hardware devices and a viable low cost approach. Accurate detection rates, with low false detection frequencies can therefore be attained. The method is also robust and flexible enough to be applied to different image types and conditions.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A verification method for determining areas within an image corresponding to monetary banknotes, the method comprising:

dividing the image into a plurality of image sections;

generating a banknote boundary map having border sections selected from the image sections, the border sections corresponding to a boundary of monetary banknotes within the image;

generating a texture decision map having texture sections selected from the image sections, the texture sections having a texture value within a valid range according to a valid monetary banknote;

determining a number of objects in the texture decision map by removing texture sections in the texture decision map that correspond to the border sections in the banknote boundary map;

calculating a texture property value for each object according to a texture feature map having a texture feature value for each image section;

calculating a shape property value for each object; and

further removing texture sections from the texture decision map corresponding to objects that do not have the texture property value within a first predetermined range and the shape property value within a second predetermined range.

2. The method of claim 1 wherein calculating the texture property value for each object comprises generating a mean value of the texture feature values for image sections corresponding to the object.

3. The method of claim 1 wherein calculating the texture property value for each object comprises generating a variance value of the texture feature values for image sections corresponding to the object.

4. The method of claim 1 wherein calculating the texture property value for each object comprises generating a mean value and a variance value of the texture feature values for image sections corresponding to the object.